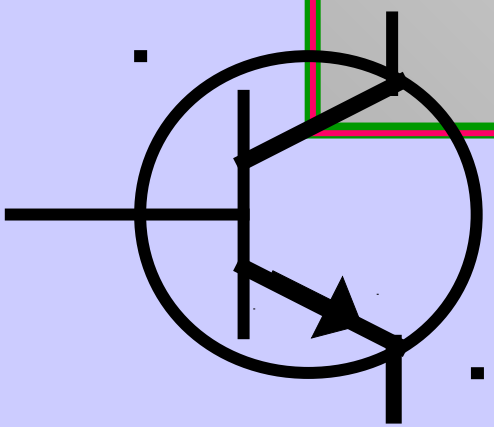
T1:

Basic Transistors

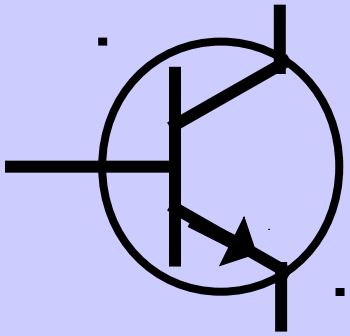
Unclassified

Safety & Environmental Impact is “LOW”



T1:

Terminal Learning Objective



Action:

Identify Transistor elements, states of conduction, operational concepts of support components, and answer all questions pertinent to the above.

Condition:

With official OMEMS Training Aid reference.

Standard:

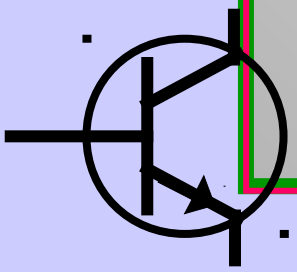
A Minimum of 7 correct answers from 10 questions.

T1:

Introduction

The first radios were very simple in design, a crystal, antenna, a coil & headset. With the advent of the vacuum tube, it was then possible to increase the power & strength of the signals. But this was not w/out cost. Vacuum tubes consumed large amounts of power & generated a lot of heat, thus accelerated the breakdown & malfunction rates in the components.

In 1945 Bell Labs developed the first transistors. This solid state device could control large amounts of current w/a small amount of voltage & current, a wave of research & development was set off that continues even to this day.

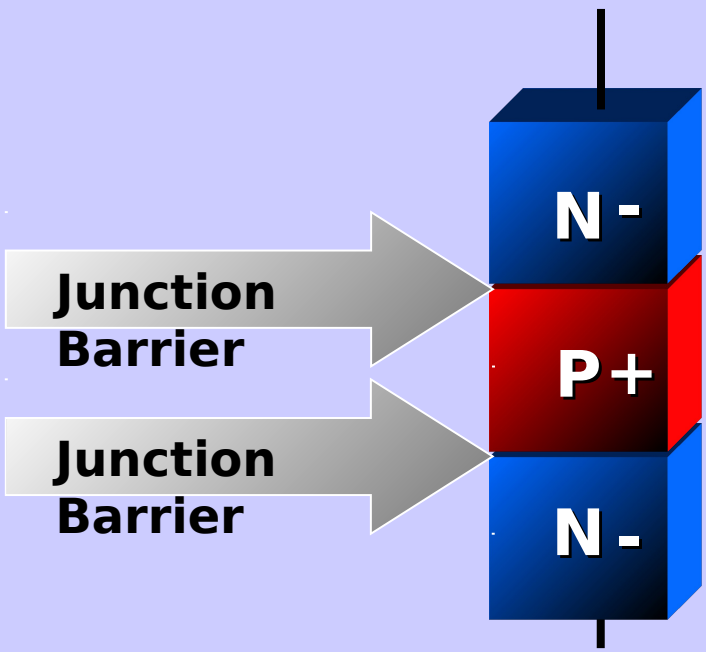


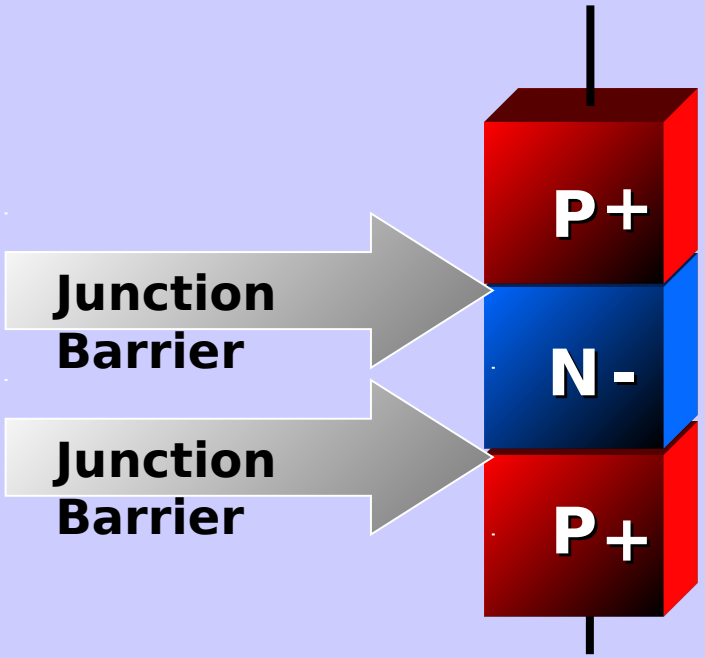
T1: Basic Transistors

TRANSISTOR:

A Semiconductor device that will control a large amount of current w/a very small amount of current or voltage .

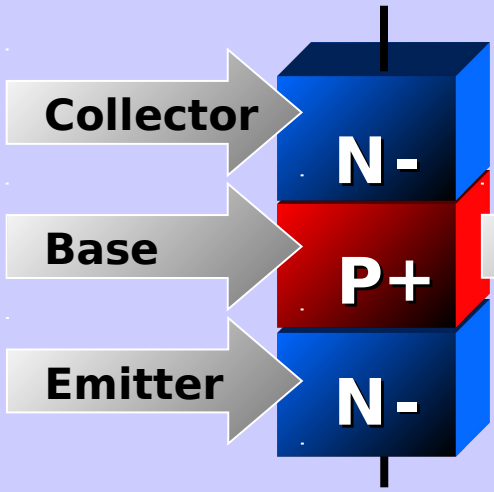
A Transistor is a <u>Bipolar</u> device, this refers to the <u>two Majority Current Carriers</u>; + Holes, - Electrons.

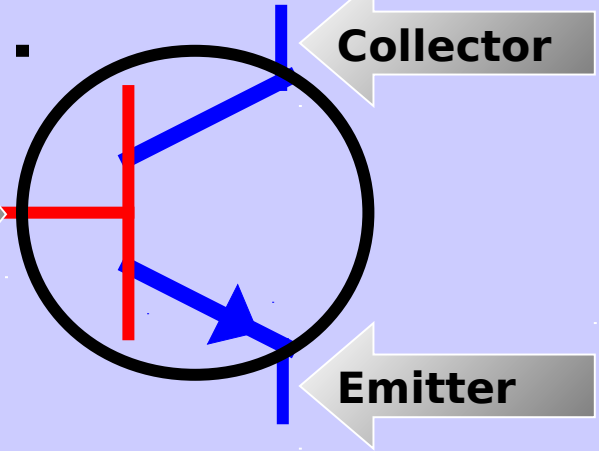




T1: Basic Transistors

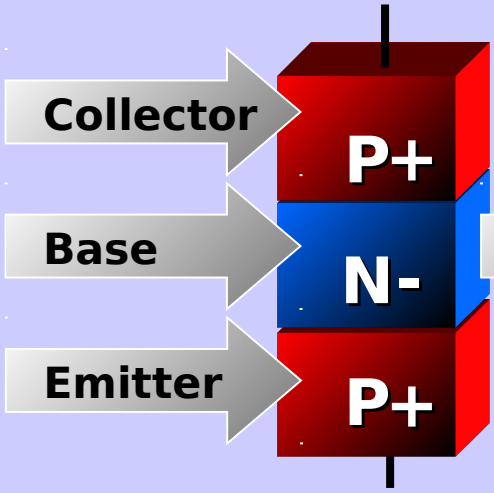
TRANSISTOR: Symbol; Q, Q1, 2,…

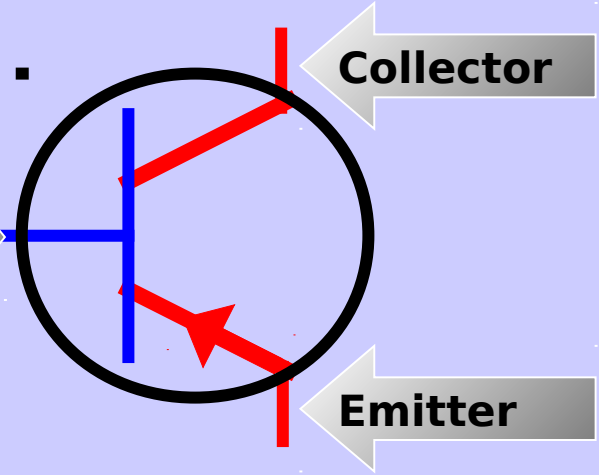




NPN:

Not pointing In





PNP:

Pointing in Point

Doping

T1: Basic Transistors

Transistor Doping level:

Directly equates w/ the % of current @ each element.

NPN: Current

100% Enters the Emitter 5% Exits the Base 95% Exits the Collector

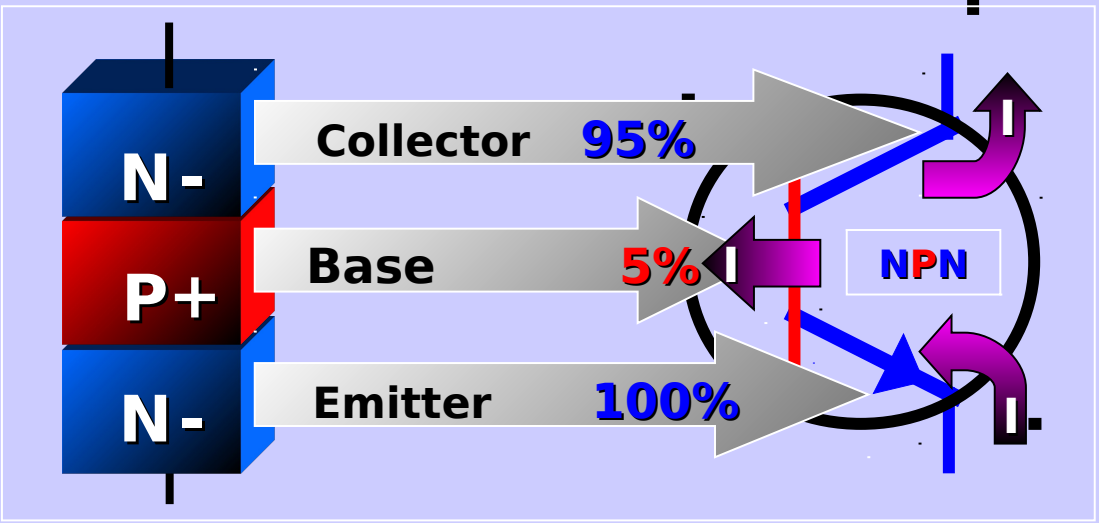
$I_B + I_C = I_E$

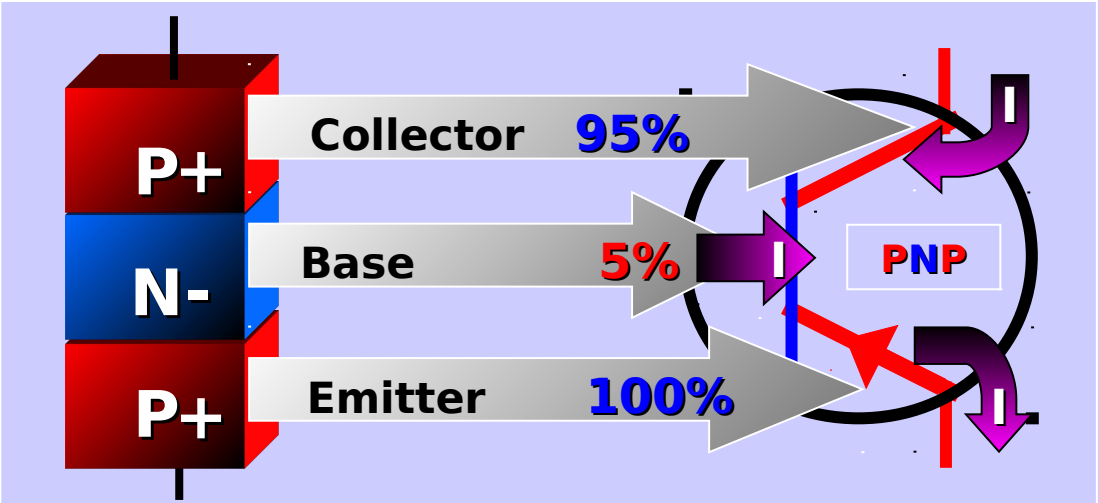
$I_E - I_C = I_B$ …

If <u>any element Increases</u> they <u>ALL Increase</u>.

PNP: Current

100% Exits the Emitter, 5% Enters the Base. 95% Enters the Collector





Note: NPN Will only be Taught. PNP is Just the opposite.

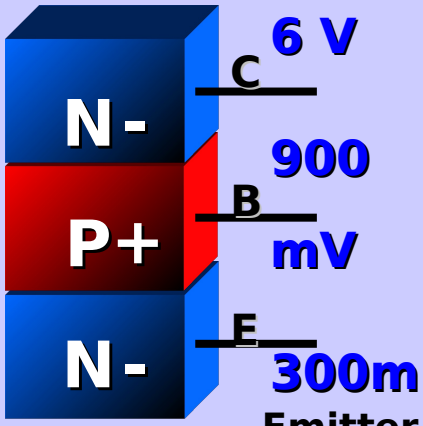
T1: Basic Transistors

BIAS:

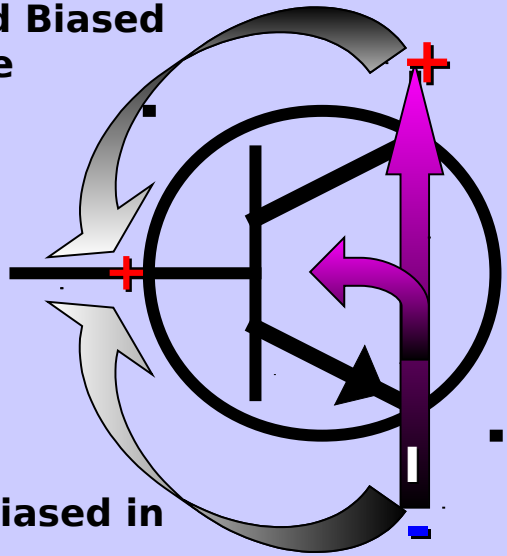
The difference of potential between two points or Elements.

NPN:

Collector is Reversed Biased in Ref To Base



Emitter is Forward Biased in Ref To Base



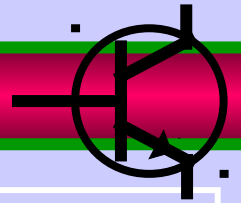
The Collector Voltage is the highest on Neg material, it is Reverse Biased.

- **The Emitter has the Lowest Voltage on Neg Material It is Forward Biased.**

NOTE: Current still flows to the most + point in the Ckt.

Conduction

T1: Basic Transistors

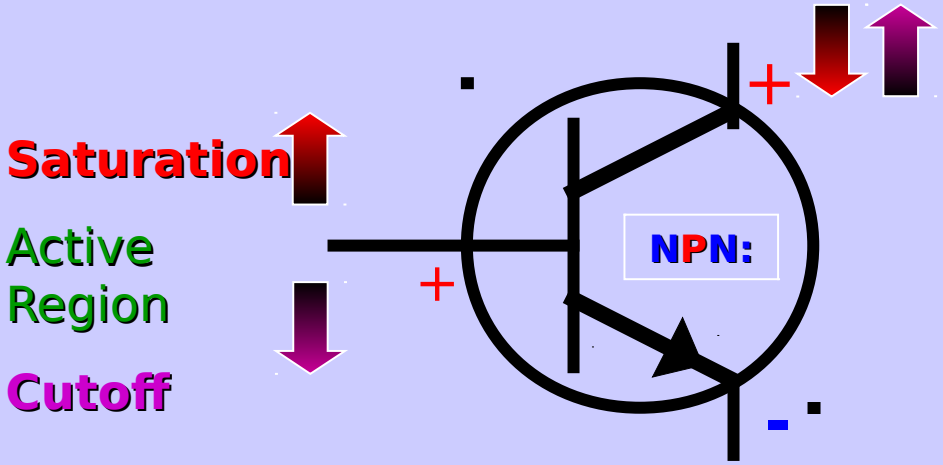


3 STATES OF CONDUCTION:

SATURATION; ↑ Bias, ↑ Current Flow Collector voltage ↓ = 0 V

CUTOFF; ↓ Bias, ↓ Current Flow Collector voltage ↑ = EA

ACTIVE REGION; Between Sat & C/O Collector voltage, ½ of EA 600 mV on Base.



Fire

T1: Basic Transistors

FIRE:

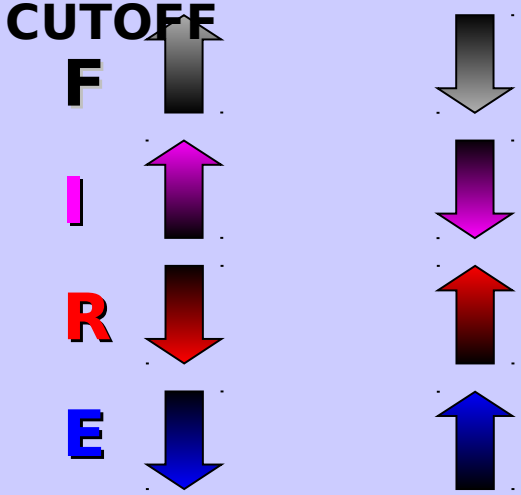
A memory aid that facilitates understanding of the electronic condition of a transistor in regards to Bias, Conduction [Current], Resistance, & Voltage @ the Collector in reference to Saturation, Cutoff & Active Region.

F **Bias**

I **CURRENT [CONDUCTION]**

R **Resistance of the Transistor.**

E **Voltage at Collector**

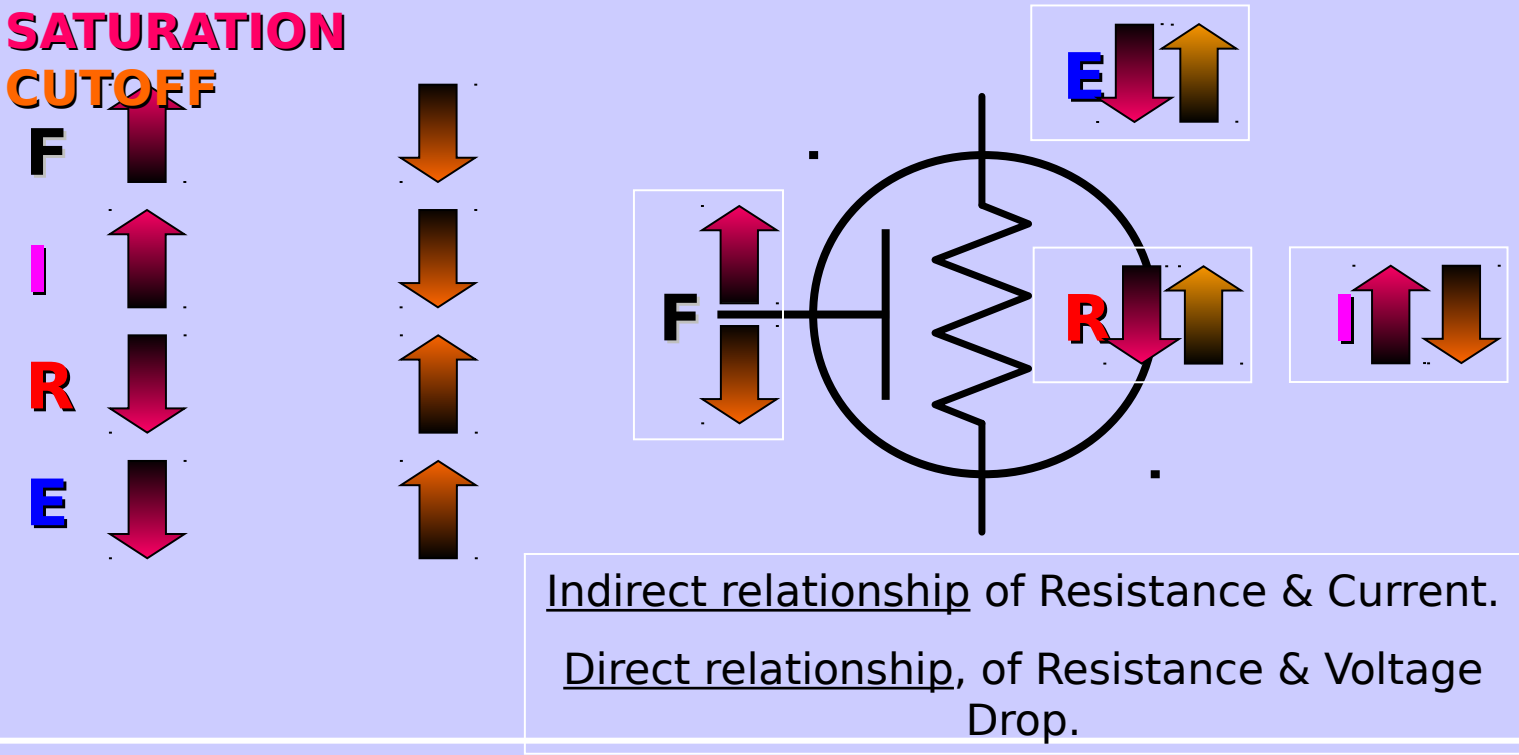


Fire

T1: Basic Transistors

FIRE:

It is helpful to think of the transistor as a variable resistor controlled by the bias @ the Base. Note the relationships dictated by Ohms Law are still observed.



Indirect relationship of Resistance & Current.

Direct relationship, of Resistance & Voltage Drop.

Ckt

T1: Basic Transistors

CKT COMPONENTS:

The transistor needs other components to set the respective bias around the perimeter & couple the signal in & out.

R1 & 2: DC Base Biasing V-Divider.

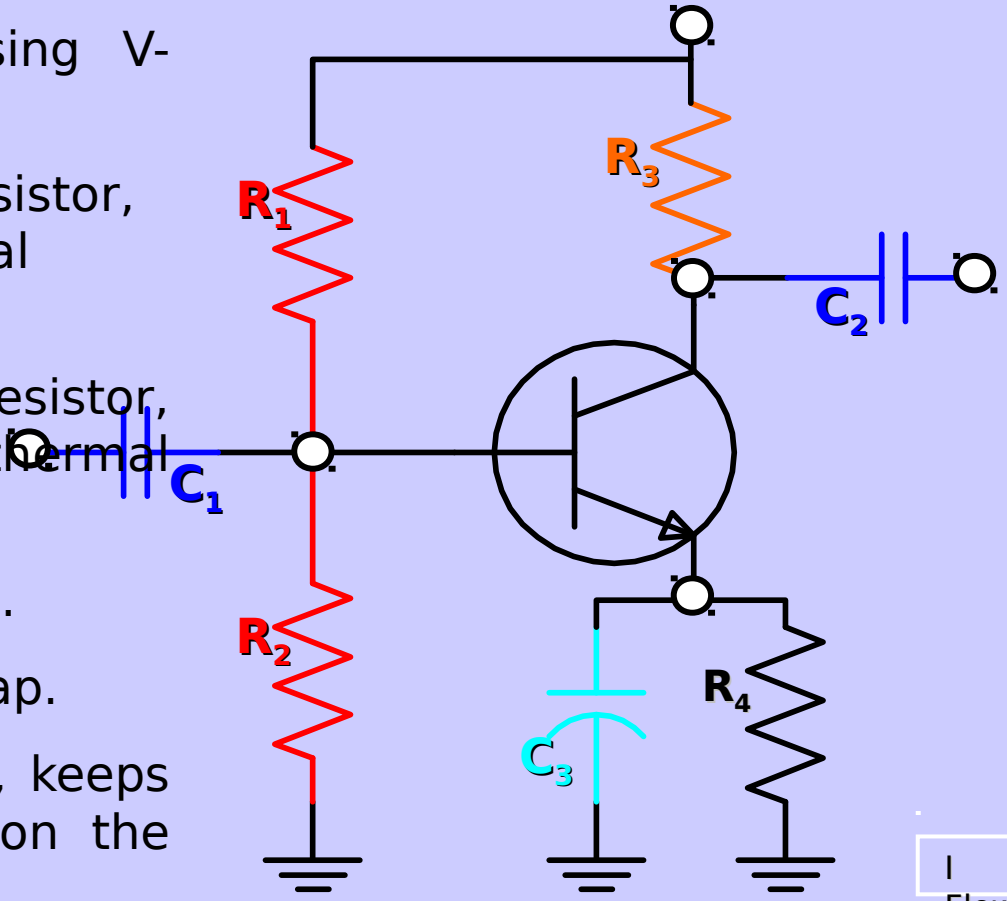
R3: Collector Load resistor, develops the output signal w/C2.

R4: Emitter Biasing resistor, prevents thermal runaway.

C1: Input Coupling Cap.

C2: Output Coupling Cap.

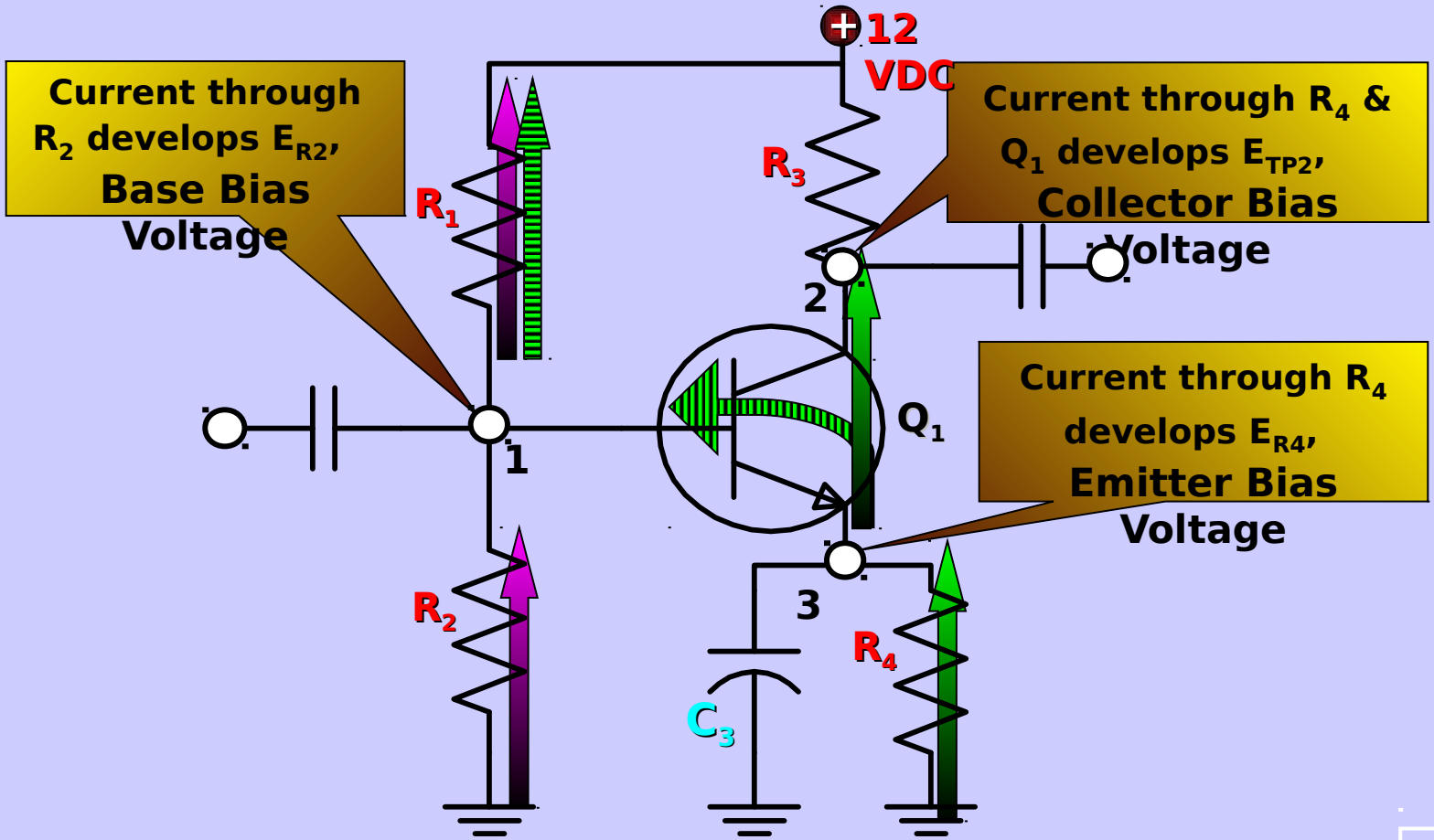
C3: Degeneration Cap, keeps AC from developing on the emitter.



T1: Basic Transistors

CONDUCTION:

With 12 DC applied, Current flows through the Ckt setting the respective bias on the transistor.

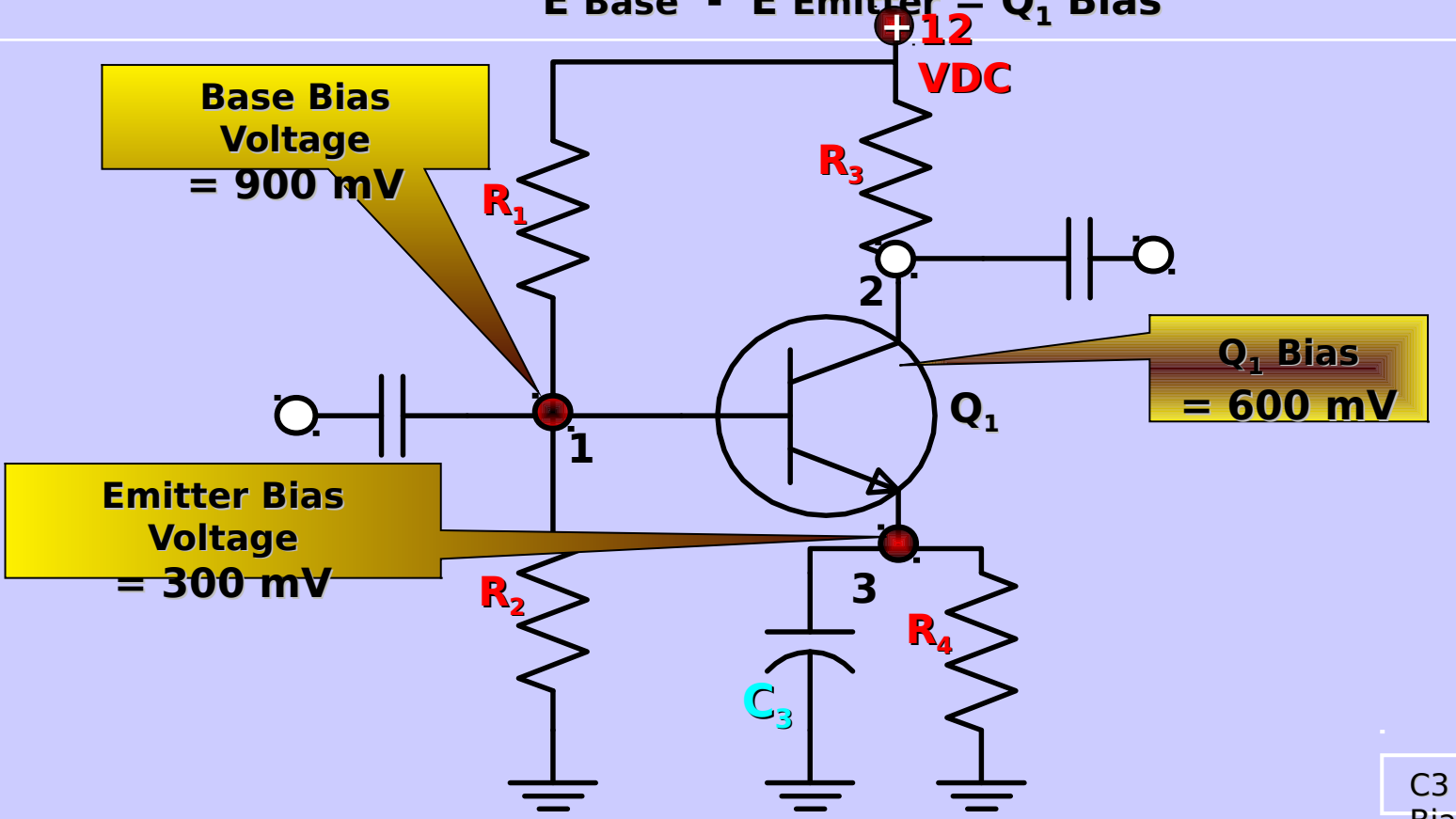


T1: Basic Transistors

Q_1 BIAS:

Is the difference of the Base & Emitter voltages, therefore the components associated W/setting the Base & Emitter Bias are responsible for setting Q_1 Bias.

E Base - E Emitter = Q_1 Bias

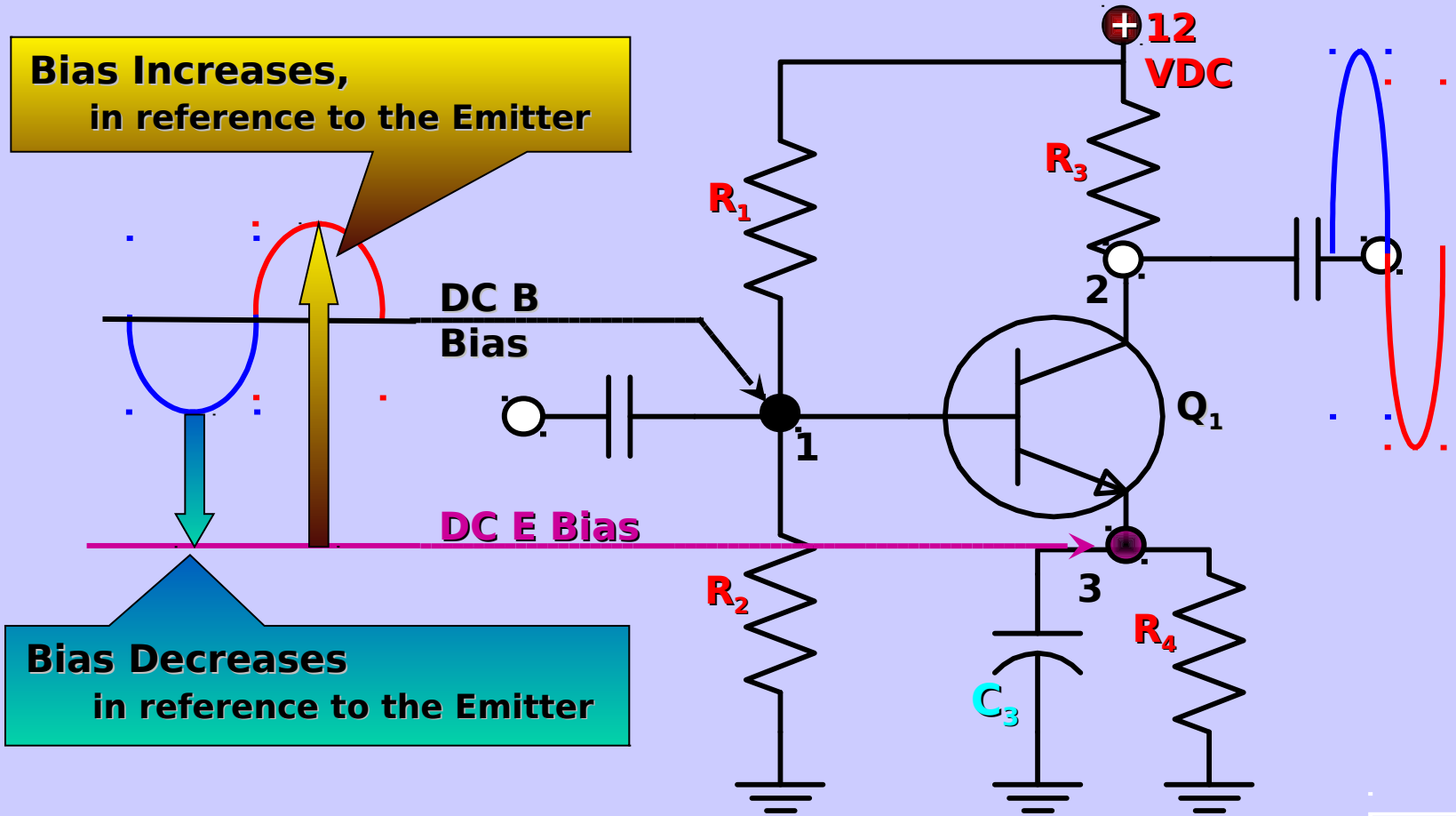


C3 & Q1 Bias

T1: Basic Transistors

C_3:

Ensures the emitter voltage stays constant, (without fluctuations)**.**
Ensures a stable point of reference at the emitter.



C3 Open

T1: Basic Transistors

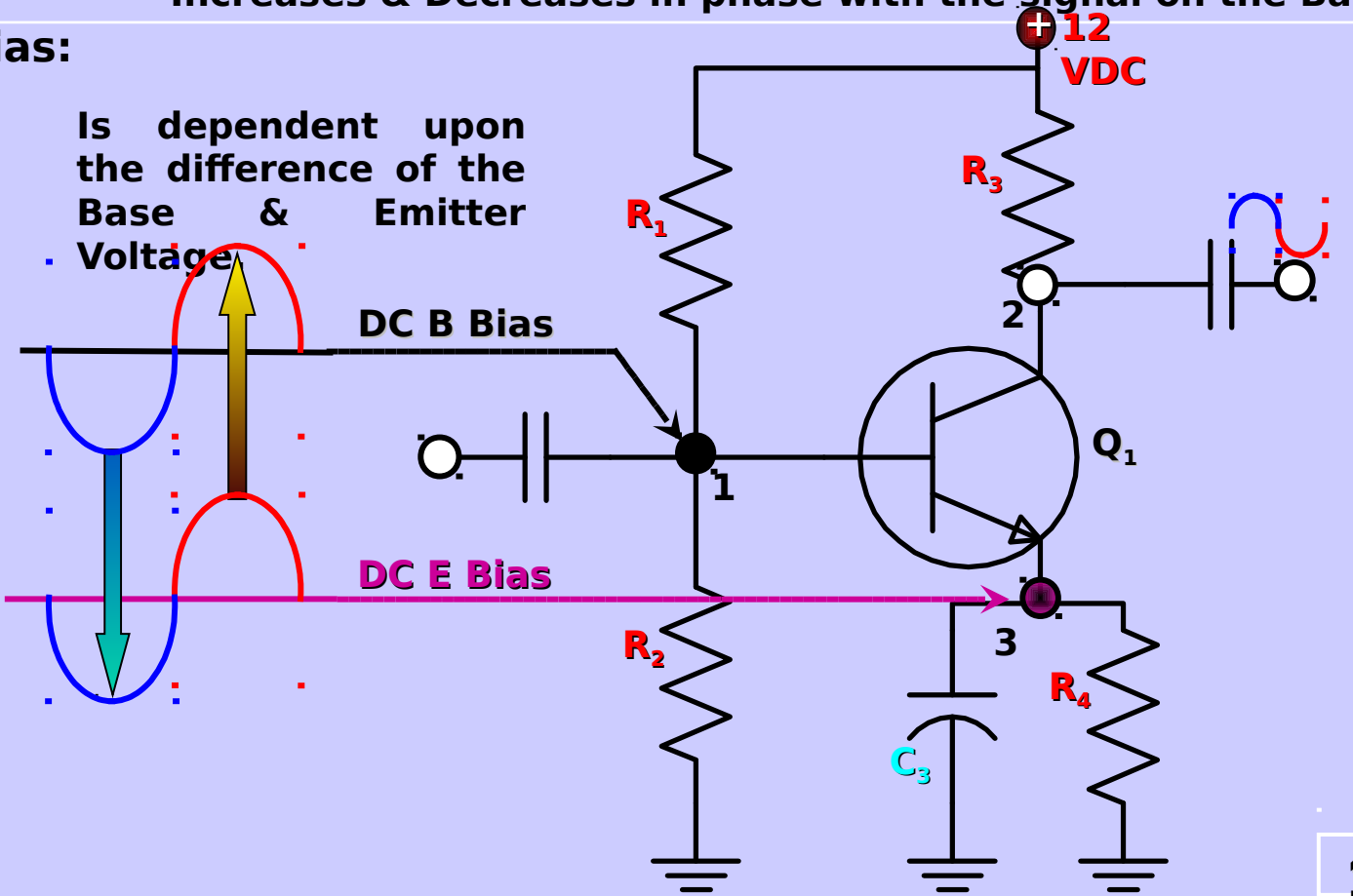
C_3 OPEN:

A signal is developed across R_4, on the Emitter.

What was a stable point of reference at the Emitter now Increases & Decreases in phase with the signal on the Base.

Q_1 Bias:

Is dependent upon the difference of the Base & Emitter Voltage



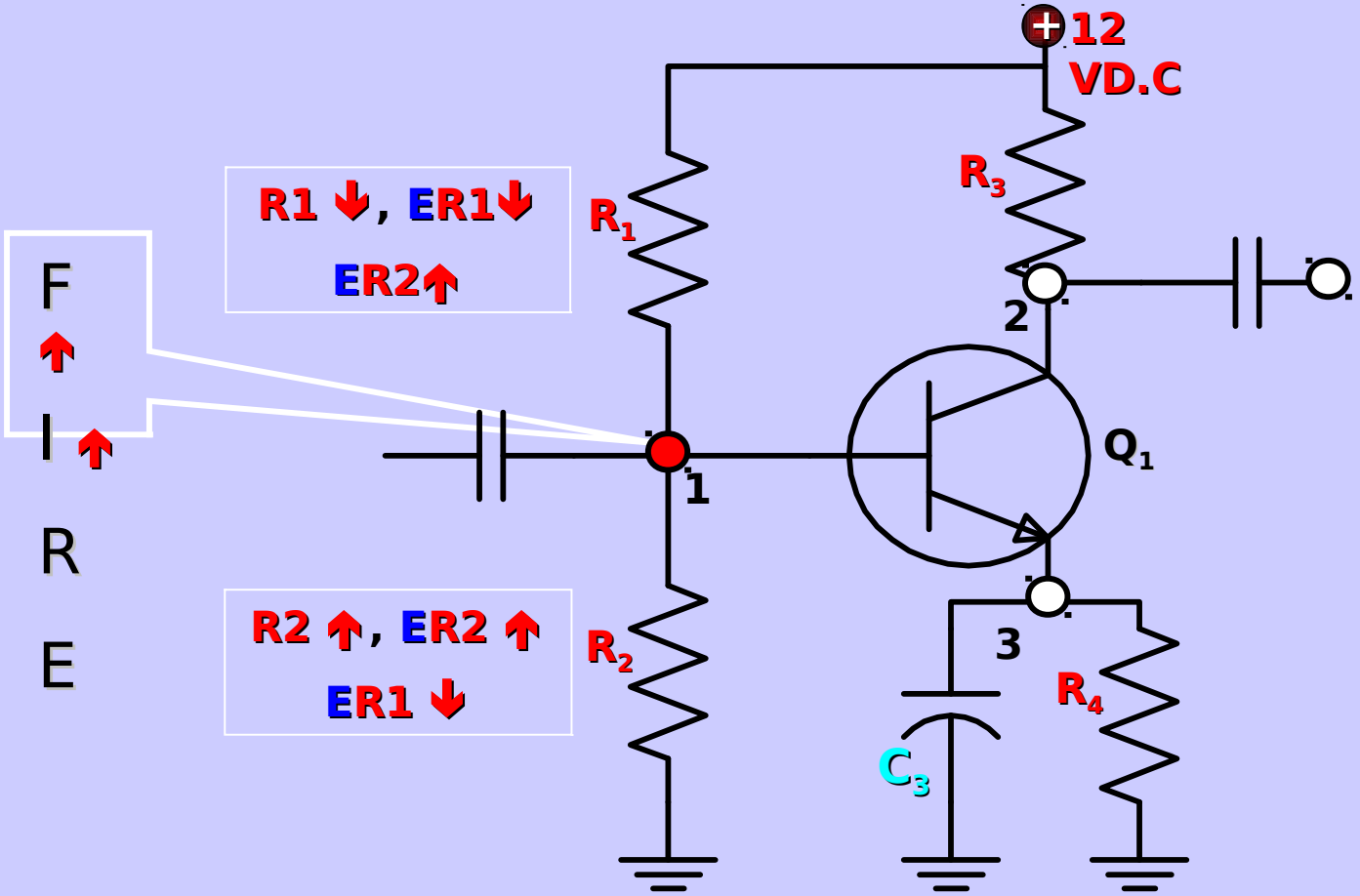
↑↓ R1 &2 Bias

T1: Basic Transistors

INCREASE BIAS OR **CONDUCTION:**

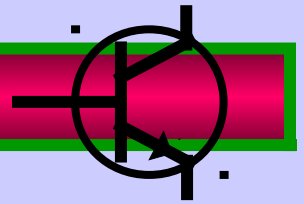
R2 can be increased or **R1 decreased.**

The voltage drop of R2 determines the bias @ the base & conduction.



Review ?

T1: Basic Transistors

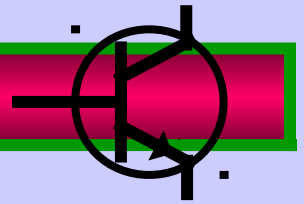


REVIEW QUESTIONS:

1. What are the three elements of a transistor?
   _____ , _____ , _____ ,
2. Which of these elements control the conduction level of the transistor? _____ ,
3. What 2 types of current flow in a transistor?
   _____ & _____ ,
4. How can a transistor be identified as a PNP or an NPN?
   _____ ,
5. What does the term “Bias” mean? _____ ,.
6. What are the two types of bias? _____ & _____ ,
7. How is the Base-Emitter PN junction biased for normal operation? _____ ,

Answers 1-7

T1: Basic Transistors

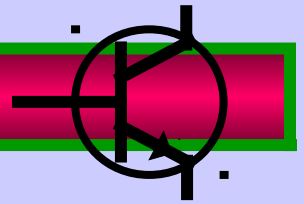


REVIEW QUESTIONS:

8. How is the Base-Collector PN junction biased? _____ ,
9. How is bias furnished to the transistor in actual operation? _____ ,
10. How many current paths are there in the basic transistor circuit covered in this lesson? _____ ,
11. What are the two basic voltage dividers in a basic transistor amplifier circuit? _____ ,
12. What are the three levels of conduction taught in transistors? _____ , _____ , _____ ,
13. Which level of conduction is described when approximately half the applied voltage is measured on the collector of the transistor. _____ ,
14. What is the condition of the transistor when there is no current flow through the device? _____ ,

Answers 8-14

T1: Basic Transistors



REVIEW QUESTIONS:

15. What level of conduction is described when minimum voltage is measured on the collector of the transistor?

    _____ ,

16. What % of total current flows in the Base circuit?

    _____ ,

17. What is the function of a resistor in the Emitter circuit?

    _____ ,

18. What % of total current flows in the Emitter circuit?

    _____,

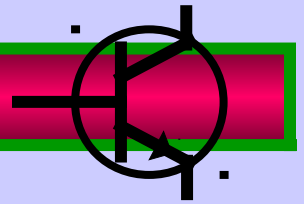
19. What are the two current carriers taught in Basic Transistors? _____ , & _____ ,

20. In a transistor the Base current is:

    _____ ,

Answers 15-20

T1: Basic Transistors



SUMMARY & REVIEW :

Lesson Test:

Standard:

10 Questions, 7 correct answers W/in 20 Minutes.

Reference: **Official OMEMS Training Aids.**

End